BRUMFIEL

A Preliminary Study of Certain Coleopterous Larvae Particularly of the Family Elateridae

Entomology

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A PRELIMINARY STUDY OF CERTAIN COLEOPTEROUS LARVAE PARTICULARLY OF THE FAMILY ELATERIDAE

BY

DANIEL MILTON BRUMFIEL

A. B. Lombard College, 1912

THESIS

Submitted in Partial Fulfillment of the Requirements for the

Degree of

MASTER OF ARTS

IN ENTOMOLOGY

IN

THE GRADUATE SCHOOL

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June 5th 1903

I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

Daniel Milton Brumfiel

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DEGREE OF Master of Arts

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Table of Contents

Chapter I. INTRODUCTION ..... pp. 1- 4

Chapter II. METHODS ..... pp. 4-11

THE DIMMOCK-KNAB CAGE
- Process of Construction.
- Painting the Cages.
- Time Required and Cost of Material.
- Exceptions to the Hypothetical Perfections of the Cages.

THE SALVE-BOX CAGE

Chapter III. THE LARVAE ..... pp. 11-37

RECORD OF THE LIVING LARVAE PER CAGE.

DISCUSSION OF THE LARVAE BY GENERA.
- Key to Genera.
- Ludius.
- Melanotus.
- Elater.
- Athous.
- Campylus.
- Limonius.
- Drasterius.
- Asaphes.
- Agriotes.
- Cardiophorus.
- Monocrepidus.
- Cryptohypnus.

Chapter IV. CONCLUSIONS ..... pp. 37-38

Chapter V. BIBLIOGRAPHY ..... pp. 38-42

Chapter VI. SUPPLEMENT. OTHER COLEOPTEROUS FORMS .... pp. 42-44

- Tenebrionidae
- Pyrochroidae
- Carabidae
- Bibliography

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A PRELIMINARY STUDY OF CERTAIN COLEOPTEROUS LARVAE PARTICULARLY OF THE FAMILY ELATERIDAE.

Chapter I.

INTRODUCTION

As the title of this report indicates, the study upon which it is based has had to do primarily with larvae of the family Elateridae, commonly known as wireworms, and only incidentally with other coleopterous forms. For many years the wireworm problem has been a serious one with the economic entomologists, yet throughout the great mass of entomological literature the notable contributions to a knowledge of the subject may be counted on the fingers of one hand. To be sure these insects have been the subject of no little comment and experiment station records contain innumerable notes upon them. These notes are perhaps of value as economic data but contribute little to systematic entomology. The many of these reports which I have examined contained no more information, for example, than, "During the summer of 1907 several fields of corn were badly damaged by wireworms of an unknown species", or, "Many specimens were found eating the grains of wheat as it was ready to sprout. These answered to the description for Agriotes mancus, given by Forbes, but as yet no reliable method of combating these pests has been discovered". Thus it is seen that this subject has at once opened an inviting field

for research into which, especially from the systematic standpoint, there are hardly the beginnings of paths. While the economic side of the problem first held attention the necessity for determining the species of each specimen led to the centering of study upon the systematic phases of the subject, with but incidental observations on the ecology of the material which was being dealt with. This report is not offered as a contribution to the scientific knowledge of the immature forms of the Elateridae but simply as indicating a first glimpse into an intensely interesting field of study, the subject of which, the writer hopes, at some time, to make the basis for a more extended study.

Upon the surface the systematic study looks simple enough - merely the breeding of the larvae until they emerge as beetles for determination of their species, a description of the larval forms and the preparation of a key from their structural characteristics. But to accomplish anything worthy of note in a one year's study is quite different for as yet practically nothing is known concerning the life history of these forms. The actual mength of the larval period is still a matter of conjecture - thought to be between two and four years for the various species. The method adopted in attacking this problem, however, was quite simple. The forms of most frequent occurrence were to be studied with the hopes of finding characters upon which a table, or key, for the determination of species might be based; some suitable breeding

cage was to be devised and a number of the cages made; into these cages were to be placed living specimens of as many of the common forms as it was possible to secure, with the expectation of rearing them to the adult form to make their indentification sure and undeniable. While the work was actually taken up in an order similar to the one mentioned above it has seemed best to vary this in the discussion, treating of the breeding cages first, the experiments with the living larvae next, and presenting the systematic notes following upon this. The miscellaneous notes form a supplement.

Chapter II. Methods.

THE DIMMOCK-KNAB CAGE.

In a paper by George Dimmock and Frederick Knab on "The Early Stages of Carabidae", published as Bulletin No. 1, Springfield Museum of Natural History, an idea was found which was used as a basis for making the breeding cages. In this paper the authors discussed such a cage which they had found satisfactory in their work with Carabid larvae. This cage was constructed of plaster of Paris and consisted of two compartments, the larger of which was designed to contain the specimens and the smaller to contain water, keeping a natural condition of moisture by seepage into the larger compartment and avoiding its direct introduction into the so-called "living room". With this idea in mind cages of similar construction were planned of three sizes - four by six inches, five by seven inches, and six by twelve inches, the latter for use when a large number of specimens of the same species were to be studied. The construction of these devices naturally involved first the construction of some suitable forms upon which to mold the plaster of Paris but these are discussed in detail later in the article. The cages used in this work were, therefore, of plaster of Paris, of the three sizes mentioned, and consisted of a large compartment for the larvae and a smaller compartment for the water supply. A smooth bottom of some substance impervious to water was also desired and this was obtained by fixing a piece of glass window pane, of the same rectangular dimensions as the cage, to the bottom of each cage

while the plaster of Paris was still soft, which by the drying of the substance became firmly cemented in place. Another piece of glass provided a cover through which the contents of the living room could be observed at will. Figure 1 is a miniature photographic reproduction of one of the small (4" x 6") cages viewed from above, without the glass cover. This is a poor print but it serves to show the general appearance of the finished cage with its two compartments. Figure 2 shows the writer's desk in the laboratory upon which are a few of the cages ready for specimens. In the large cage on the extreme left may be made out the pieces of earth in which the living larvae were placed. Natural conditions were preserved in these cages by providing a part of the natural habitat of each species studied; that is, those specimens which were obtained from decaying wood were kept in decaying wood and those obtained from sod were kept in earth and pieces of sod.

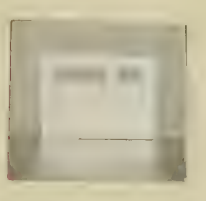

Figure 1

Figure 2

As the actual method followed in the construction of the cages was of considerable importance it has been thought best to discuss it in this report. Of first importance under this comes the description of the forms about which the plaster

of Paris was molded, with, secondarily, an account of the actual process and such details as painting, etc.

Description of forms. Three forms, one for each size of cage, were made by Harold M. Trusler of Indianapolis, Indiana. These were wooden and consisted of (1st) a strong piece of wood, at least one-half inch thick, with at least one smooth surface and one inch greater in length and breadth than the intended cage. This formed the base or floor of the form. (2nd) Two blocks of the exact dimensions desired for the compartments, immovably fixed to the base in positions in relation to the edges and each other as was desired for the compartments. (If these forms should ever be made of metal it would be well to have both blocks and base molded as one piece.) (3rd) Detachable sides which might be temporarily fixed to the base, extending about one-half inch above the blocks, forming a box about the blocks into which the soft plaster of Paris could be poured, the inner dimensions of this box coinciding with and determining the outer dimensions of the hardened cast. These sides were one-half inch thick and made attachable to the base by means of pins on the middle of their lower edge which fit into holes bored in the base. The worker was thus enabled to quickly detach the sides of the box as soon as the substance had hardened, greatly facilitating the removal of the hardened cast from about the blocks. The entire form became the parallel of a male die upon which the cage was fashioned in an inverted position, the base determining the top of the cage and the half-inch difference between the height of the blocks and that of the sides

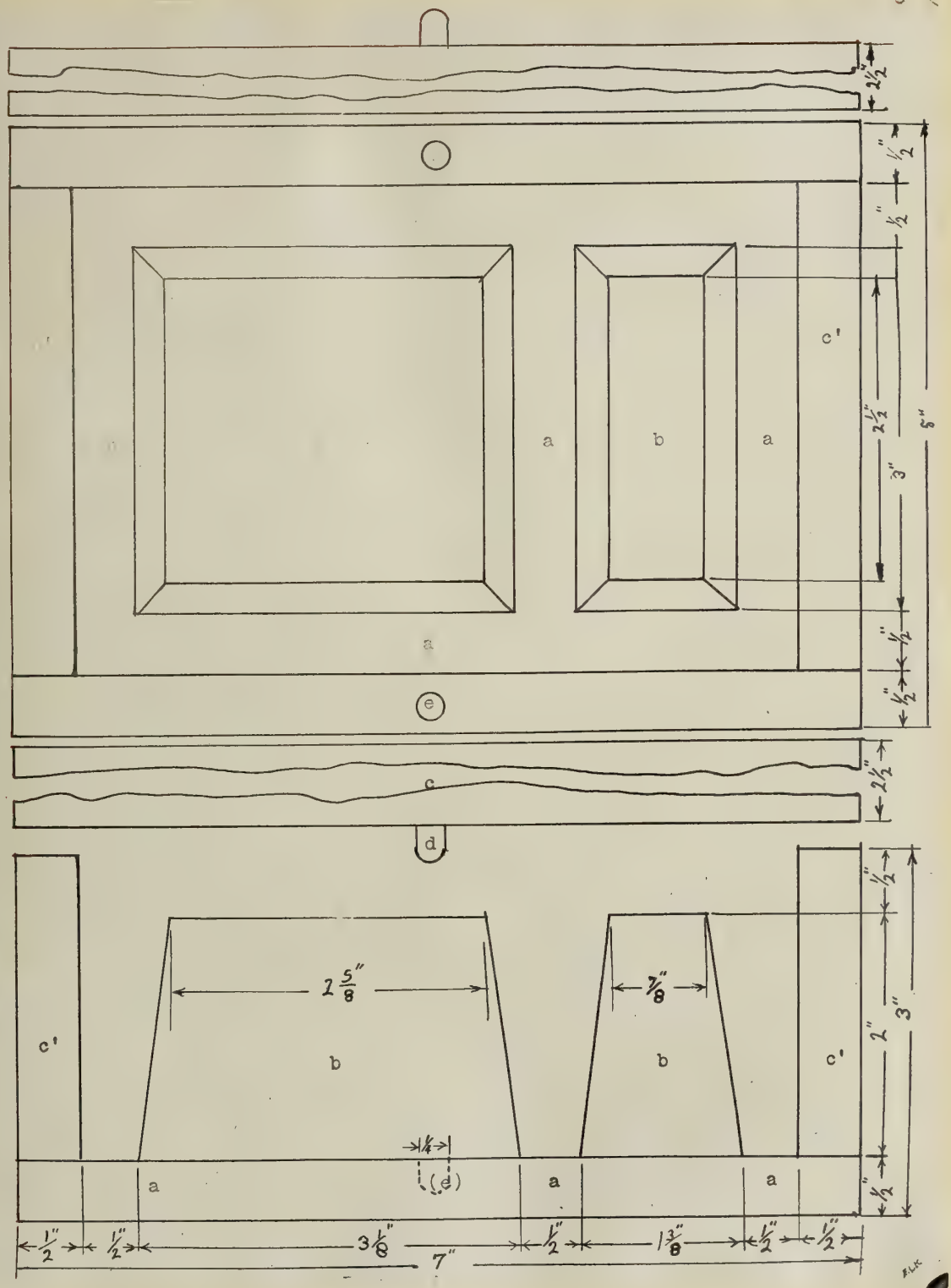
2½"
½"
½"
c'
a
b
a
2½"
3"
6"
a
½"
½"
e
2½"
c
d
½"
2 5/8"
7/8"
c'
b
b
c'
2"
3"
¼
(d)
a
a
a
½"
1/2"
1/2"
3 1/8"
7"
1/2"
1 3/8"
1/2"
1/2"

FIGURE 3

providing room for a half-inch of material between the bottom of the compartments and the bottom of the cage when the molding box was filled.

Figure 3 consists of a mechanical drawing representing two views of the hypothetical form for making cages four inches by six inches. A presents the view from above while B is a drawing of the same figure from the side. In these the long side pieces have been removed, showing the pins and pin holes in A and permitting an unobstructed view of the blocks in B. The following parts can be identified: a, base; b, blocks for determining compartments; c and c' the side pieces, of which the longer, c, have been removed and the shorter, c', are in place; d, the pin of the lower edge of side pieces which fits into the hole, e, in the base. The longer side pieces, c, are shown in A as lying at the side of the base, their longitudinal edges given and the body of each piece broken away.

Process of construction. No exact recipe was followed in mixing the plaster of Paris. The supply of the dry substance and of water were arranged near the mixing vessel, which in this case happened to be a ten-cent dish-pan. The forms were arranged in a position that would permit of their being filled most rapidly. The whole of the interior of each form-box was well greased with vaseline (there are, no doubt, many other substances which would have answered the same purpose) to prevent the plaster from becoming stuck to the wooden surfaces upon drying. The side pieces were put in place and secured by means of a stout string which was tied tightly about the box near the top, in a bow knot that could be quickly loosened. The box, or boxes, being ready, just enough

plaster of Paris was prepared by the addition of water to fill the waiting form or forms. After a few casts have been made the worker can estimate very accurately the amount necessary for filling the forms with a minimum of waste. It was found best to transfer the plaster to the form while it was still soft enough to be poured. The box-form was filled, and before the substance had time to harden the piece of glass intended for the bottom of the cage was placed on top of the soft plaster and pressed down firmly enough to remove all air spaces between plaster and glass. This insured the cementing of the glass in place.

As soon as the plaster of Paris had become firmly set the side pieces were detached and the cast cage removed by carefully inserting a strong thin metal blade between the base and the cast at different points until it was seen that the separation was well started. The cast could then be carefully lifted from the base and blocks. Any remaining bits of plaster were scraped from the wood, the surfaces greased as before, the side pieces fixed in place, and the form was ready for another filling of plaster.

Painting the cages. Upon testing the cages by actual use it was found that the living room failed to maintain a proper degree of moisture even though it was necessary to renew the water supply in the small compartment daily or oftener. This difficulty was easily met, however, by applyong a coat of common shellac to the four sides of the cages, stopping all outward evaporation. This was accomplished most quickly by grasping the cage by the partition between the compartments

and lifting it. It could then be turned about and all four sides treated at one operation.

Time required and cost of materials. After a little practice the writer was able, using only one form, to take casts from the form at the rate off our per hour. This, however, was better than the average rate as the plaster of Paris is inclined to behave somewhat erratically under varying conditions. In all, thirty-four of the cages were made from fifty-five pounds of plaster of Paris. Probably eight or ten pounds of the material were wasted in unsuccessful molds and in occasionally mixing more than was necessary to fill the forms, as the plaster can never be used again after having once become set. The total cost of the materials used in the construction of the thirty-four cages, not including the forms or mixing vessels as they can be kept and used indefinitely, covering plaster of Paris, glass, vaseline, and shellac was less than four dollars ($4), or less than twelve cents each.

Exceptions to the hypothetical perfection of the cages. In general the cages proved to be nearly ideal for the purpose for which they were made. A few notable exceptions show, however, that some difference in composition should be considered if extensive experiments are to be carried on. These exceptions were betrayed by that fact that certain larvae, of the Carabidae, the Phyrochroidae, and a few forms of the Elateridae, were able to nore into the plaster of Paris floors and walls of their living rooms after the plaster had become slightly softened by the moisture from within. Some of these effected their

escape in this manner and will be mentioned again in the discussion of the larvae.

SALVE-BOX CAGE. A few life history experiments have been started, using common small tin boxes as cages. There has not been time to give these a thorough testing, but Dr. A. D. MacGillivray, who suggested using such salve boxes for this purpose, reports good results with this plan in a few experiments which he has already completed and from experiments conducted several years ago. The plaster of Paris cage has but one advantage over the salve-box, namely the glass top, but it is of such small importance in breeding coleopterous larvae that the balance of good qualities is strongly in favor of the tin salve-box. The latter is to be desired for the following reasons: (1st) the metal of the tin box renders the escape of the larvae absolutely impossible; (2nd) if the box is kept closed to larvae remains undisturbed and the moisture in the earth or rotten wood in the box, obtained by adding a few drops of water every ten days or fortnight, is not susceptible to evaporation; (3rd) the boxes are light, convenient for handling, clean, and take up very little space, a gross of the proper size for individual larvae can be easily carried in a small travelling bag; (4th) they are very inexpensive, as those with a paper top, convenient for recording data on the box itself, can be purchased in gross lots at less than one cent each.

Chapter III.

THE LARVAE

The adult beetles of this family, Elateridae, are well known, not only to entomologists but to almost every boy who has made the acquaintance of nature's wonders. To the boy these are known as click beetles or "snap-jacks" and he has played with them for hours, probably, not realizing that the structure which made possible their ability to snap up into the air, in an attempt to regain their feet when he placed then on their backs, was a character that has been used for grouping them into a systematic family. The larvae, however, are not so readily distinguishable. They are generally known as wireworms but while this title is in a way descriptive of many species, others are very unwireworm-like in appearance. There are other coleopterous larvae that may justly be called wireworms by those who have not made a study of the particular structures of the true wireworms. Larvae of the family Tenebrionidae, which resemble the larvae of the Elateridae very closely in many particulars, for instance, can be distinguished from those of the Elateridae by the presence of a well defined labrum, while certain of the Carabidae, without labrum, can be readily be distinguished by the presence of two claws on the tarsi where the true wireworms have but one. As far as the studies of the writer have been conducted, a combination of characters, the absence of a visible labrum together with the single clawed tarsi, can be relied upon to separate the larvae of the Elateridae from similar forms.

Within the family other characters are used for differentiating the genera and species. Many of these characters are found on the last* segment of the body, such as differences in outline of the entire segment, as toothed, rounded, ovate, conical, pointed, or ending in a pair of lobed prolongations; differences in size and shape of the lobes of the prolongations, number and arrangemtns of tubercles; differences in sculpturing of the surface of the segment; differences in size and shape of the anal segment proper, armed or unarmed with hooks; differences in appearance on the thoracic and abdominal segments such as sculpturing, presence, size and shape of striated muscular impressions** on the dorso-lateral aspect of these segments; and to a certain extent, differences in structure of the head and mouth parts.

The life history of the Elateridae, as has been indicated, is very imperfectly known. Dr. Forbes, of Illinois, and Professor Slingerland, of Cornell, have made careful introductory studies but the publications of these investigations contain nothing more definite than inferences as to the probable

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*The segment which forms the tip of the body is not in reality the last segment but the penultimate one. The last segment is properly that which bears the anus but as the anus of wireworms is some distance removed from the tip of the body, on the ventral surface, it has become customary to treat that segment which forms the tip of the body, when viewed from the dorsal aspect, as the last segment. It is so treated in this article.

**The term, "striated muscular impressions", does not have any reference to striated muscles, as might be inferred, but is applied to sculptured areas in the chitinous surface of the body. The areas appear as dark brown blotches or spots but when viewed under the microscope reveal (as described by Forbes, 1894) a more or less oblong slightly depressed background of light color across which extend transversely, a number of parallel, elevated, brown ridges - the striae. The dark brown appearance is due to these striae.

length of the larval period and the time of pupation and emergence of the beetles. The work of these noted entomologists was done with larvae of the genera Melanotus, Agriotes, Drasterius, and Asaphes, with notes on a few others, which comprise the greater numbers of our forms of economic importance. It is thought by them that the larval period may be of three or four years duration and that pupation occurs in July or August, the most of the forms hibernating as the adult in the pupal cell and a few emerging in the fall to hibernate under shelter of debris, decaying wood, etc. As the breeding cage experiments recorded here have been carried on for only a few months, and as only one larva has pupated to date, this a woodland form, the writer has no data to offer either in substantiation or repudiation of their inferences.

The writer's own collections, which are represented by living larvae in the breeding cages comprise eight genera; viz., Ludius, Melanotus, Elater, Drasterius, Asaphes, Limonius, Campylus, Athous. For this work no living specimens were secured of the two genera - Agriotes and Cardiophorus , which are generally known to be injurious. The larvae mentioned above were classified into the above genera by the use of a key to genera given by E. Perris on pages 185-188 in his Larves de Coleoptores, (1877), verified and assisted by data given in Dr. Forbes' papers. The writer feels, however, that much of the material now available, especially the tables for identification, except the separate work of Dr. Forbes and Professor Slingerland,* should not be considered authoritative until further work has verified

*The descriptions and keys given by these men were based, at least partly, on reared material and are not to be questioned.

it. A translation of Perris' key to genera is submitted in this report.

RECORD OF THE LIVING LARVAE PER CAGE

Cage No. 1. Ludius.- March 14 - Placed 14 specimens, collected in Fayette County, Indiana, December, 1912, in the cage. 12 of these were stupid and seemed sick, probably due to having been in a small bottle for several weeks. March 15 - Removed one dead specimen. March 16 - Removed one dead specimen. They were fed a few grains of corn soaked in water every few days. April 3 - Returning from absence of ten days a few of the grains of corn has sprouted and grown 2 or 3 inches, other grains had had the heart completely eaten out. April 7 - 3 of the specimens were taken out and examined. Clusters of whitish, semi-transparent mites, very small, were found to have collected near the apex of the last abdominal segment and in the region of the thoracic legs. These parasites seemed to impede the activities of the wireworms in no way. April 12 - 11 specimens were examined, all of which bore mites. The remains of one dead specimen was found. April 14 - 1 uninfested specimen, collected in Brownfield Woods, April 13 was added. April 22 - 1 specimen from Brownfield Woods was added. May 20 - 2 specimens were examined. The number of mites had increased but the specimens were exceedingly active and appeared healthy.

Cage No. 18. Ludius.- April 7, 4 larvae placed within, collected in decaying wood, Fayette County, Indiana, May 30, 1913. No transformation to date.

Cage No. 23. Ludius.- 46 specimens collected in rotten

wood, Fayette County, Indiana, during April, were placed in cage April 23. They were fed grains of corn which they hollowed out.

Cage No. 4. - Elater, and an unknown Elaterid (?) larva - Placed in cage April 8. No results.

Cage No. 7. - Athous (?). - April 7, 2 specimens placed in cage, collected in rotten wood (beech forest) Fayette County, Indiana, March 30. (A similar specimen from same locality is preserved in alcholol). April 12 - Both had disappeared by boring into the pieces of rotten wood in the cage.

Cage No. 11. - Athous (?). - April 8, placed within, 2 specimens collected in rotten wood, Brownfield Woods, Urbana, April 6. Perhaps predacous, as one specimen had its mandibles sunk into a soft bodied Carabid larvae when found. April 12 - Hidden out of sight in the bits of rotten wood. May 26 - one larva had pupated into a slender white pupa with exceptionally free appendages.

Cage No. 13. Athous. - 2 specimens collected in decaying wood, Brownfield Woods, Urbana, April 6. April 8 placed in cage. No results.

Cage No. 19. Asaphes (?). - May 2, 5 specimens of Asaphes collected by Grizzell, in sod, placed in cage.

Cage No. 32. Asaphes (?). - 3 specimens of Asaphes (?) collected by Paul Neff, in sod, Fayette County, Indiana. Put in cage April 22. No results.

Cage No. 9. Melanotus. - 2 specimens collected from decaying willow wood, Fayette County, Indiana, March 23. (See description of Melanotus sp. 8) Placed in cage April 7. April

21 specimens had disappeared by boring out through walls. Had eaten of sprouting corn in cage before escaping. One of them found again May 20 in another cage.

Cage No. 10. Melanotus. - 3 specimens collected under log in Brownfield Woods, Urbana, April 6. Placed in cage April 7. April 21, one had bored a hole through the wall and escaped; 2 remained and were transferred to another cage. The corn had been eaten at heart.

Cage No. 19. Melanotus. - 1 specimen of this genus collected from decaying apple wood, Fayette County, Indiana, April 1. April 8 placed in cage. April 21, had eaten of corn and bored out.

Cage No. 31. Melanotus. - 13 specimens placed in cage April 30. Collected under bark and stumps of logs 1 1/2 miles north of Urbana. No transformations to date.

Cage No. 12. Campylus (?) - 2 specimens of Campylus, collected in rotten wood, Brownfield Woods, Urbana, April 6; placed in cage April 7. No results.

Cage 20. Campylus (?) - 2 specimens collected in decaying wood, Brownfield Woods, Urbana, April 6. Placed in cage April 8. No results.

Cage No. 15. Elater. - 3 specimens; 2 large ones collected in Fayette County, Indiana, March 25 - 1 small one collected in Brownfield Woods, Urbana, April 6. All from rotten wood. Placed in cage April 7. April 12, hidden in the bits of rotten wood. April 21, they had eaten into the grains of corn in the cage.

Cage No. 16. Elater. - 6 specimens collected in Fayette County, Indiana, March 24, in decaying wood. April 8, placed in cage. April 12, corn added. April 21, they had eaten into corn.

Cage No. 28. - 27 specimens of wireworms of genera Drasterius, Melanotus, Limonius, and Asaphes collected by Paul Neff, in sod, during April, Fayette County, Indiana. Placed in cage April 23. April 26, the specimens of Drasterius taken from cage and placed in a tin salve-box.

Bottle cage of Melanotus. - A number of Melanotus larvae taken from under bark of logs and stumps about 1 1/2 miles north of Urbana, placed in a large bottle, as no empty cages were at hand. No results observed.

These breeding cage experiments on account of their brevity, failed to give additional data on the transformations of the Elateridae. They should be considered as the initial steps in this work and are offered merely as such. One observation, however, should be emphasized: Many of the specimens collected from rotten wood, especially Melanotus* and Elater, fed freely of the corn planted in their cages, even though they were kept in a supply of decaying wood - their natural habitat and food supply although it has been suggested that they may be predaceous. This has indicated to me that woodland forms, feeding normally on decaying wood, or predaceous on other forms in decaying wood may become injurious to corn

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*Dr. Forbes reports Melanotus fissilis as having been taken in both rotten wood and cornfields.

in land that has been but recently cleared.

DISCUSSION OF THE LARVAE

(By genera, with descriptions and figures)

The amount of time which the writer was able to devote to the strictly systematic phases of this work permitted a careful, comparative study of but a few forms. It was the writer's aim, therefore, to confine his attention chiefly to some of the more common species. These will be taken up by genera with such notes on species as this study permitted. The descriptions are in most cases brief and very incomplete, and only those of the drawings which the writer feels are reliable and of importance are presented. Practically all the drawings contained in this report are original, and references are given to figures by others of forms, which have not been illustrated. Credit is given in the case of more figures which have been copied from other authors. The following key to genera, translated from Perris (1877), is the one which was used, as far as possible, in determining the genera of specimens.

Key to Genera

A. Epistoma and labrum lacking or imperceptible by reason of their union with the front; anterior edge of head notched.

B. Body subdepressed, moderate size, ordinarily a trifle more narrow at the two ends; last segment bordered laterally with tooth like indentations ordinarily blunted, and terminated by 2 bilobed prolongations, leaving between them a deep hollow.

C. These prolongations terminated by 2 or 3 lobes or teeth.

D. Lobes of terminal prolongations equal.

a. Last segment convex above, covered with stiff spines, stronger as they are near the posterior edge; anal projection armed with spines. Last segment marked with 4 grooves, of which the two middle ones are short..... Chalcolepidius.

Last segment marked with 2 grooves only.....Alaus.

aa. Last segment concave above; anus placed between 2 hooks at the extremity of large anal projection (which is) more or less free, destitute of other small spines.

Anal projection a little free, protected along the sides with horny granules having a bristle on each; last segment with lateral obtuse indentations, its dorsal surface marked by longitudinal grooves and by waved wrinkles systematically arranged ..... Lacon.

Anal projection large and free, moving itself like a valve (or plug) under the last segment; this latter with indentations laterally acute; its dorsal face strewn with small granules ..... Adelocera.

aaa. Last segment flat or very slightly convex above, seeming concave by reason of the toothed edges. Anus placed at the extremity of a conical projection, retractile and without hooks, inclosed in a rim in a half circle; segments of the abdomen strongly dotted above, on more than the anterior half .... Athous except mandibularis

Last segment and anus like the preceeding; segments of the abdomen with a slight reticulation (?),

or at least marked with some points, except the final one which is wrinkled and cut by four furrows..... ... s.g. Diacanthus & s.g. Tactomus

Like the preceeding, but the first 8 segments of the abdomen having each, 4 furriginous spots on a pale yellow ground .. s.g. Hypogamus

Like Diacanthus but last segment very wrinkled ..... s.g. Corymbites

Like Diacanthus but last segment scarcely as long as the sixth abdominal segment and the two intermediate segments very short..... ..... s.g. Actenicerus

DD. Lobes or teeth of terminal prolongations unequal, the inside lobe much the shorter.

External tooth turned outward, crocked, vertically raised; segments of abdomen smooth above or showing a few small points ..... Athous mandibularis.

External tooth turned in a straight line and raised in a hook; segments of the abdomen marked with points transversely confluent on the anterior two-thirds of their dorsal face ..... Campylus

CC. These prolongations not lobed or toothed and converging so that the extremities almost touch ..... Limonius.

BB. Body subcylindrical and horny.

a. Body smooth.

Shape large, last segment elongated, conical, rounded at the extremity; anal projection very small, of a width scarecely equal to a fourth of that of the last segment at its base..... Ludius.

Shape small, last segment moderately long, semiellipsoidal, terminated in a point made blunt; anal projection almost as wide as the segment at its base..... ..... Drasterius.

Final segment long, demi-ellipsoidal, level or more often a trifle concave above and marked with 4 grooves on nearly the anterior half; terminated by three tooth-like indentations of which the middle one is the longest; anal projection large, nearly as wide as the segment at its base ..... Melanotus.

aa. Body marked with scattered dots.

Final segment moderately long, demi-ellipsoidal, terminated by a point, having at each side, near the base, a cavity of the appearance of a large scar..... ..... Agriotes.

Final segment conical, terminated by a small acute point, ornamented with large setiferous tubercles arranged in 3 transverse series of which the first is at the middle of the segment and the last two at the base of the terminal point ..... Dolopius

aaa. Body more strongly and more densely dotted, especially on the last segments.

Last segment long and regularly demi-ellipsoidal, terminated by a point, marked with two dorso-lateral grooves; anal projection not exceeding the anterior two-fifths of this segment ..... Elater.

Final segment marked thus with 2 dorso-lateral grooves, semi-elliosoidal but not very regularly, by reason of a sinuosity that exists near the extremity; terminated, either by 3 lobes, the two lateral being slightly marked and the medium one terminating in a point, or by 3 nearly equal teeth; anal projection attaining 3/4 the length of this segment ..... Megapenthes

BBB. Body cylindrical, membraneous (except the thorax which is sub-horny), pitted, and very supple; the first 7 segments of the abdomen susceptible to lengthening by being drawn out in such a manner that each appears composed of 3 rings; these same segments as well as the 8th are deeply fluted. Mandible abnormal, divided into 2 branches, of which only the upper is toothed, Last segment long and narrowly semi-elliptical; anal projection

free, terminated by two membranous pseudopodal appendices, bent and divergent ..... Cardiophorus

AA. Epistome and labrum very distinct, anterior edge of head not indented ..... Cryptohypnus

Perhaps the commonest of all woodland wireworms are the larvae of the genus Ludius. Blatchley (Coleoptera or Beetles Known to Occur in Indiana) mentions but one species, L. attenuatus, of common occurrence in Indiana, and another, L. abruptus, which is rarely found. As the same general conditions of ditribution hold for this section of Illinois as for Indiana, as as the working collection contained many specimens from the latter State the writer sought to differentiate the larvae into these two species if possible. The external structure of many specimens was studied with careful attention to detail, but no characteristics were found by which they might be definitely divided. Certain variations in the anterior margin of the epistoma were found, but these could not be considered as anything more than variations, as they completely intergraded. It is presumable, then, that our common Ludius is most likely to prove to be L. attenuatus.

This larvae is one of the largest and most beautiful of our wireworms. The body is slender, circular in cross section, of a uniform circumference, heavily chitinized, highly polished, and of a glistening reddish brown color, shading into black on the anterior margin of the head. It is ten or eleven times as long as broad, in which aspect the outline drawings, (Figure 4 of the dorsal aspect, and Figure 5 of the ventral aspect), are slightly out of proportion. The darkened drawings

of the head, (Figure 6, dorsal aspect, and Figure 7, ventral aspect), deserve a word of apology and explanation. No attempt was made in laying the washes on the original drawings to distinguish between shadows and high lights but simply to differentiate between corneous areas, chitinous areas, and membranous areas. The mandibles are represented in black, the chitinized areas in grey, and the membranous areas in white. The irregularities in the grey portions were not evident in the originals, but appeared unexpectedly in the photographic prints when it was too late to have them done over. The homology of the mouth parts can readily be made out from these figures. The spiny legs are indicated in Figure 8, anterior aspect of the right metathoracic leg. Figure 9 shows the lateral aspect of the fourth abdominal segment. Figure 10 shows one of the spiracles of the first abdominal segment with its connection with the tracheal trunk. Figure 11 gives, in bare outline, the abrupt narrowing dorso-ventrally, of the head into a wedge shape when viewed from the side.

Melanotus.

The most of the time devoted to the systematic studies was spent in studying the larvae of this genus. These comprise a large part of the common injurious forms, particularly noted for their damage to corn. There are many species of Melanotus; but only two American forms have been described in detail; M. communis and M. cribulosus by Forbes, and M. communis independently by Slingerland. In this work the writer examined all the specimens available, including those in the State Laboratory of Natural History collection; and believes

that there are certain larval characteristics which may be relied upon for the determination of species when once representatives have been reared actually to establish their identity. Those specimens examined fell more or less accurately into nine* types which are in all probabilities true species. While a few of these types have been reared by Forbes and his assistant, until the names of all have been determined by breeding, the writer has chosen to consider them numerically for the present. The following key to these species, derived from these studies, is based largely on the presence and size of the striated muscular impression found on the thoracic and abdominal segments, together with certain characters.

Key to Numerical Species of Melanotus

A. With a distinct row (transverse) of fine setae near the cephalic margin of dorsal and ventral aspect of, at least, 3rd to 5th abdominal segments.

B. With a pair of dark, unstriated, spot-like impressions on the ventral aspect of last segment, cephalo-laterad of anal proleg ..... sp. 8

BB. Without dark impressions on ventral aspect of last segment; body slightly depressed ..... sp. 9

AA. Without distinct transverse row of fine setae on dorsal and ventral aspect of abdominal segments 3 to 5.

B. Without striated muscular impressions on thoracic or abdominal segments. Apex of last segment not more than 3-toothed..... sp. 2

BB. With striated muscular impressions on, at least, abdominal segments.

C. With more than 18 striae in muscular impression of 4th abdominal segment ..... sp. 5

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*Dr. Forbes reports the recognition of perhaps seven types.

CC. Without 18 striae in muscular impression of 4th abdominal segment.

D. With 12 or more striae in muscular impression of 4th abdominal segment.

E. With 12-15 striae in impression of 4th abdominal segment. Last segment 5-toothed ..... sp. 6

DD. Without more than 12 striae in impression of 4th abdominal segment.

E. With more than 9 striae in impression of 4th abdominal segment. With 10-12 striae in impression of 4th abdominal segment ..... sp. 4

EE. With less than 9 striae in impression of 4th abdominal segment. With 4-5 striae in impression of 4th abdominal segment.

F. Impression of last segment large, 9-13 striae ... sp. 1

FF. Impression of last segment small, 3-5 striae.....

G. Sharply 5-toothed.. sp. 3

GG. Not sharply 5-toothed ..... sp. 7

Species 1. (Figs. 12-19). - Undoubtedly Melanotus cribulosus, as it was bred in abundance for Dr. Forbes and described by him. Body practically cylindrical and circular in cross section, segments of same width except that head may be slightly narrower than prothorax; evenly corneous throughout, darker toward the head, there is a transverse irregular dark ridge near the anterior margin of each abdominal segment, extending almost to the pleurum where it bends suddenly caudad. (See Figures 14 and 15). Viewed from the dorsal aspect the muscular impressions of the thorax and abdomen appear as brown spots

close to the dark ridge near the cephalic margin of each segment, situated dorso-laterad (See Figure 12). The prothorax is fully as long as both mesothorax and metathorax together, these latter about equal in length. Abdominal segment varying somewhat. Ninth abdominal segment from 1 1/4 to 1 1/2 as long as eighth. Ninth abdominal segment (Figures 12, 13 and 14) strongly convex on cephalic half dorsally and ventrally; flattened at apex, terminating in tridentate margin apically. No lateral carinated margin except at toothed portion at and near apex. On dorsal aspect the surface of the segment is sculptured with four longitudinal furrows on cephalic half; the two outer furrows arising from near the middle of the muscular impression and extending caudad either parallel or very slightly incurved, conforming to outline of segment; inner furrows curved, arising a short distance caudad of a line drawn through origin of outer furrows, these curves presenting a convex line to the reson. Caudal half of the segment strongly punctate with distinct punctures. Ventral surface less prominently punctate than the dorsal surface. Muscular impressions small; very narrow, with short striae, in the mesothorax and metathorax, growing broader and more nearly round in each succeeding segment to the eighth abdominal; smallest in abdominal segments 3-5 where only 4-5 striae are present (see Figure 15); more striae on thoracic impressions (see Figure 16); perhaps 10 or 12 on last segment (Figure 12), largest on this segment where each impression is oblong in outline, notched on middle of caudal half. This notch marks the point of origin of outer furrows. Anal projection free, semi-elliptical in outline of base, basal ring cordlike

and striated; almost as wide as segment at base, not extending caudad half the length of the segment; anal protuberance small, not more than 1/4 as wide as last segment (Figure 13). Head (without mandibles) somewhat quadrangular in outline, with a slightly concave cephalic margin on dorsum. (See Figure 17). Labrum invisible; epistoma broad, shaped like a fat "T", Base of "T" truncate, almost as wide as the somewhat constricted juncture of stem and cross bar; epistoma forming cross bar, notched on cephalic margin, median projection of which makes prominent tooth; mandibles arcuate with short blunt tooth at middle of arc. Labial palpi distinctly visible from above. Antennae very small, three segmented, third segment very minute, situated in depression formed between dorsal and ventral articulation of mandibles, second joint scarcely extending cephalad of median tooth of epistoma. Gula very narrow, (See Figure 18) lateral margins practically parallel abruptly coming to a rounded point at caudal end. Labium free, with two two-segmented palpi. Maxillae narrowly quadrangular in shape, slightly narrowed caudad with rounded caudal corners.

Legs small, anterior pair slightly smaller than either of the others; armed with rows of short, stiff, dark spines chiefly on cephalic, mesal and caudal sides, leaving definite spineless area on lateral aspect of each joint (See Figure 8, Ludius). Prosternum convex cephalad of legs; mesosternum and metasternum flat. First abdominal sternum deeply convex which in contrast seems to bulge pouch-like caudad of metathoracic legs, the ventral margin, and therefore the ventral margin of the whole abdomen, seeming nearly on a plane with the joint

between the metathoracic femur and tibia when the insect is viewed from the lateral aspect. Spiracles present on abdominal segments 1 and 8; oblong - a narrow chitinized rim with a chitinized bar running longitudinally, connecting with each end; respiratory slits on each side of this longitudinal bar (See Figure 19). Mesothoracic very similar, in some cases more narrow in outline.

The foregoing is the only detailed description given. The other hypothetical species have been compared with this type and only those characters mentioned which show departures from this type.

Species 2. - The same general description given for Species 1 applies to this form with the important exception that it lacks the striated muscular impressions on both the thorax and abdomen. The dorsal aspect of the last segment is less coarsely and less densely punctate on caudal half.

Species 3.- (Figs. 20-21). Labeled M. americana in the State Laboratory collection. This name is undoubtedly correct as Dr. Forbes reported adult and larval skin taken in same cell. The same in general description as Form 1 and Form 2 except for possible greater slenderness and certain differences in last segment. Muscular impressions of abdomen on first eight segments similar to those of Form 1, obvate-circular in form. Muscular impression of last segment circular, very small, consisting of 3-5 striae; lying well dorsad of the origin of the origin of the outer longitudinal furrows. The dorsum of the last segment is sparsely marked with tiny tubercles over the greater part. The margin is sharply toothed. Irregularities

of ventral surface so faint as to be distinguishable.

Species 4.- (Figs. 22, 23, 24, 25, 26 and 27). The description was made from larvae represented by Figures 22, 23 and 24. The other figures were made of larvae, only a few in number, which, according to the key given, belong to Species 4, but differ in respect to the outline and sculpturing of the last segment. It is possible of course that these are of a different species. Similar to Species 1 in general appearance. Outline of last segment distinctly 3-toothed but differing somewhat in shape. Dorsal surface of last segment somewhat rugose, punctate sparcely on caudal half. The usual 4 longitudinal impressions on cephalic half with an additional impressed line on the meson of caudal half of segment arising from a point immediately caudad of a line drawn transversely through the obsoletion of the inner furrows and extending caudad nearly to the base of the median apical tooth. Muscular impressions large, those of the fourth abdominal segment with 10-12 striae. Last segment of antennae barely visible, knob-like.

Species 5.- (Fig. 25) Muscular impressions very large, with about 20 striae; the impressions extending in a thin vanishing line well up onto the dorsal surface of the body. Last segment five-toothed, rather sharply. Dorsum of last segment thickly punctate with a few scattered papillae among punctures. Rugose, feebly punctate and papilliate beneath.

Species 6.- (Figs. 29-30). Muscular impressions large, with about 12-15 striae. Last segment 5-dentate, bluntly. Dorsal and ventral surfaces of last segment sparcely papillose, somewhat rugose; punctures, if present, small and scattered.

Species 7.- Figs. 31-32). Muscular impressions small, those of the last segment with only 3-5 striae, situated well mesad of the origin of the outer furrows. The last segment blunted, the lateral outline of caudal half waved but not rendering margin distinctly toothed as in other types;one blunt tooth at apex. Posterior two-thirds of last segment obliquely flattened caudally; dorsum with a few scattered but very distinct papillae.

Species 8. Muscular impressions of abdomen with about 12 striae. Last abdominal segment but little if any longer than the one before it; not long drawn out but abruptly toothed; distinctly 5-toothed, the toothed edge forming an elevated margin about the posterior half of segment. Dorsal surface of last segment flat, quite rugose, longitudinal furrows as in Species 4. Base of anal proleg extends over cephalic half of segment, semi-circular. Cephalo-laterad of anal opening is a pair of characteristic irregular, dark, unstriated, spot-like impressions. On the dorsal surface of abdominal segments 3-7 is present a more or less distinct transverse row of fine setae; on the ventral surface a similar transverse row of setae is present on segments 3 to 6. (See Figure 36, Species 9).

Only two specimens of this type were found but these escaped from their cage before any drawings were made. One was recovered but not until the complete set of drawings was returned from the photographer and thus too late to be figured.

Species 9.-(Figs. 33-36). Body very slightly depressed. With a distinct transverse row of fine setae at the cephalic edge of the dorsal and ventral surface of abdominal

segments 3 to 6. Four prominent wavy parallel furrows, extending caudad from the cephalic margin of last segment to about half way the apex. Base of anal prolog semi-circular, extending caudad to about the middle of the segment. The anal projection large, fully one-third as wide as the segment, its anterior margin near the anterior margin of segment.

Elater.

Specimens of Elater (Figs. 37-47) while not so common as Ludius or Melanotus were frequently collected in decaying wood. It was not the writer's intention to give them any especial consideration but the recognition of certain structural differences in the field led to an examination in the laboratory of the material at hand. These specimens fell naturally and distinctly into four types. These are certainly to be treated as species. No detailed descriptions of these forms were made but drawings are presented which show those characters necessary for distinguishing between them and a key to these hypothetical species based upon this character is given. These, as those of Melanotus, are considered numerically for the time being.

Key to numerical species of Elater

A. With striated muscular impressions on the abdorinal, and mesothoracic and metathoracic segments.

B. Muscular impressions of abdomen lying on a line parallel to the cephalic edge of the segment; epistoma with a single pointed median tooth.

C. Muscular impressions on abdomen extending dorso-mesad from a point a little above the spiracle, gradually narrowing until the striae are lost on the dorsum not far laterad of the meson ..... sp. 1

CC. Muscular impressions clearly defined, rarely more than twice as long as broad; small and faint on last segment ..... sp. 2

BB. Muscular impressions on abdomen not lying on a line parallel to the cephalic edge of segment but extending obliquely, dorso-caudo-mesad; epistoma with a 3-lobed median tooth ..... sp. 3

AA. Without striated muscular impressions ..... sp. 4

Species 1.- (Figs. 37-40). Surface of body irregularly pitted. Last segment ovate-conical gradually rounded to the acute point at tip; an area of heavy dark semi-circles cephalad of the muscular impressions; surface of segment densely and evenly punctured with circular pits, rather faintly on the ventral aspect; cephalic two-fifths of dorsal surface marked with four longitudinal lines, slightly converging, of which the inner two are the shorter; muscular impressions large, parallel to cephalic margin of segment. Epistoma with single median point.

Species 2.- (Figs. 41-42) Very similar to Species 1 in general appearance and outline. Last segment more coarsely punctured; with only two longitudinal lines. Muscular impressions smaller than those of Species 1, rarely more than twice as long as wide, those of last segment very small, even to faintness. Epistoma with single pointed median tooth.

Species 3.- (Figs. 43-45) Chiefly characterized by the fact that the muscular impressions are large, extending in an oblique line. Pits of last segment very minute and dense. Segment abruptly rounded.

Species 4.- (Figs. 46-47) This species is characterized by the absence of striated muscular impressions. The last segment is less ovate, nearly conical, gradually tapering to a

point, quite long. Dorsal surface of last segment marked with a narrow transverse area of dark semi-circular figures on its cephalic margin, the remainder very densely and minutely pitted. The abdominal segments cephalad of the last minutely pitted and marked with a raised, dark, irregular line on the dorsal surface extending laterad and ventrad to the pleural conjunctiva.

Athous.

The drawings (Figs. 48-49,53,56), serve to give the characterists of the last segment. The finding of a pupa in Cage No. 11 has made possible a more careful study and description of the larva of this form. The following description was made from the preserved larval skin, found with the pupa.

The larva is medium in size, head and last segment narrower than the other segments which are broader than long. Dorsal surface of each segment dark, almost black, with a light yellowish band at the cephalic and caudal margins near the retriculation. The ventral surface of the segments, except the last, smooth or with very slight punctures; light yellowish in color. The dorsal surface of abdominal segments, 1-8 marked with a dark, slightly wavy elevated ridge extending from the meson laterad until it reaches nearly to the edge of the dorsal aspect where it curves caudad and vanishes just before reaching the yellowish band.

The last segment is divided at the apex by 2 bilobed prolongations with a well sounded space between them. The segment is very dark, the lobed prolongations reddish. An obtuse ridge extends from the base of the outer side of the prolongations cephalad, turning abruptly mesad when near the cephalic margin of the segment, forming a shallow cup like area on the dorsal surface of the segment, with a slightly convex, rather than concave surface within the rim of the cup. On this ridge cephalad of each outer lobe, are 3 setae-bearing tubercles. The dorsal surface bears 2 short, smooth longitudinal impressions on the anterior half and a median irregular impression extending from a line drawn transversely through their point of obsolescence to the apex of the opening between the prolongations. The entire surface of the segment is irregularly but rather densely punctured, somewhat rugose above.

The ventral aspect of the last segment is characterized by the extremely large base of the anal protuberance, or anal segment proper. Thus is semicircular in outline, as wide as the segment at base, and reaches caudad nearly to the fork formed by the prolongations of the segment.

The lateral aspect of the last segment bears a few small tubercles.

The epistoma has a sharply 3-toothed median projection and is squarely truncate at base. Laterad of the base of the epistoma is a longitudinal row of four setae, the most caudal one of which lies near the caudal margin of the head.

The mandibles are arcuate with a slightly arcuate tooth on the middle of the inner edge.

A median white line lies on the dorsal surface of the thoracic and of the abdominal segments, except the last.

The pupa is very long and slender, white, and has exceptionally free appendages. A detailed study was not made of the pupa through fear of injuring the sole specimen.

Campylus.

Specimens of this genus were found only in decaying wood, and only a few of these. The larvae were subjected to no thorough study on account of their few numbers as compared with some of the other forms. Figures 50-52 were made, however, to show the generic character used by Perris in his key, namely, the long outer lobe of each terminal prolongation vertically raised in a hook. Certain differences are to be observed in the sculpturing of the dorsal surface of the last segment.

Limonius

The writer has taken specimens of this genus (Fig. 57) only in decaying wood and was surprised to receive several individuals in a collection made for this work in sod in Fayette County, Indiana, during April. One species, Limonius confusus Sec. was reported by Forbes in his 26th Report State Entomologist of Illinois as injuring root crops. It was bred and figured by him.

Drasterius

Drasterius elegans is one of the smaller species but very common and injurious. It has been described and figured, (Fig. 58), by both Forbes and Slingerland. It has been one of

the most common forms in the writer's collections from sod.

Asaphes

Asaphes decoloratus, (Fig. 59) is another rather common injurious form which has been described and figured by both Forbes and Slingerland. The larvae of this species are rather large and are represented in the working collections, from sod.

Agriotes

The common wheat wireworm, (Fig. 60), is of the genus, Agriotes mancus, and has also been described and figured by both Forbes and Slingerland as well as Webster and Chittenden. This species is not represented in the writer's own collections.

Cardiophorus

An unknown species of this genus has been described and figured by Forbes, reported by him as injurious. A single specimen was collected from decaying wood in Indiana (Fig. 61). The larvae of this genus are remarkable for their unwireworm-like appearance, membranous body covering, moniliform shape, and the division of the first seven abdominal segments into three pseudosegments each.

Monocrepidus

Chittenden (1902) made some short notes on the economic species, Monocrepidus vespertinus, with a figure of the adult and larvae. The writer has not met with this species, or any other of this genus, in the work. Chittenden's figures of the larvae were too small to be copied with any accuracy of

detail.

Cryptohypnus

One species of this genus (Fig. 62), Cryptohypnus abbreviatus, was reported by Slingerland as being injurious. He succeeded in rearing the larvae and made descriptions with figures. The writer has not met with specimens of this genus in this work.

Chapter IV.

CONCLUSIONS

The study of this subject, outlined by the foregoing report, has led to the framing of the following conclusions:

I. Larvae Must be Bred. Nothing can be really accomplished in this work without the actual breeding of the larvae. This fact was recognized by the American workers, particularly Slingerland and Forbes who did excellent work along this line.

A. In as much as certain of the larvae effected an escape the hypothetically perfect plaster of Paris breeding cages used in this work leave something to be desired.

B. The tin salve-box cage may prove to be a solution of the cage problem.

II. Larvae Can be Classified.

A. The larvae have specific characters upon which a key to most species may be based.

B. Such characters as may be preserved in the shed larval skin deserve emphasis.

III. Woodland Species may become Injurious. Many of the species commonly living in, and feeding either on decaying wood or upon other forms in the decaying wood may become injurious when recently cleared land is put into grain.

Chapter V.

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Chapter VI.

SUPPLEMENT

OTHER COLEOPTEROUS FORMS

In the work with Elateridae some other interesting coleopterous larvae were incidentally collected which were placed in breeding cages and cared for hand in hand with the wireworms. As some of these underwent transformations the writer feels that they are deserving of mention. No description of these forms were made but specimens of those which underwent complete transformation have been preserved in every stage and are thus available for description in each stage later. These larvae were of the families Tenebrionidae, Pyrochroidae, and Carabidae. The journal of the breeding cages, with a few other notes, will form a sufficient treatment of these insects for the present.

Tenebrionidae

Cage No. 6.- April 7, 2 specimens collected in rotten wood in Brownfield Woods, Urbana, Ill. April 6, were placed in the cage. April 12, both had buried themselves in the pieces of rotten wood in the cage.

These larvae were very similar to those described by Hyslop (The False Wireworns of the Pacific Coast Bull. No. 95, U. S. Dept. Agr. Div. Ent. 1912) as belonging to the genus Eleodes. The writer was unable, however, to identify them as actually being the same and they did not transform. It is possible that they were of the genus

Nyctoboles, as Eleodes has never been reported this far east.

Cage No. 17. Mercantha contracta. Several specimens collected, part from rotten wood, Fayette County, Indiana, and part from similar habitat in Brownsfield Woods, Urbana, Illinois. Placed in the cage, April 12, one long slender white pupa found in cage. April 14, 2 specimens added, collected in Brownsfield Woods. April 21, the pupa noticed on April 12 dead; 2 others found, one killed for preservation. The pupal skins preserved. April 23, 5 specimens from Brownfield Woods added. April 25, one black beetle was found clinging to under side of moss that partially covered the rotten wood in cage. May 6, two more beetles were taken from cage, one of which had evidently just emerged as it was all white except head, pronotum, legs and pygidium which were reddish brown. One pupa also removed and preserved. May 20, one black beetle removed.

Pyrochroidae

Cage No. 3.- 4 specimens, collected in Brownfield Woods, placed in cage April 7. April 14, added two specimens collected from Brownfield Woods. April 21, only three specimens seen; signs of burrowing in the plaster walls. April 23, one specimen from Brownfield Woods added. May 5, an adult female was found which had apparently emerged from a burrow in the plaster of Paris itself. By carving into the substance with a pen knife the pupal cell was found

with the larval and pupal skins still in it. Two other pupae were found within the scraps of rotten wood. One dead larva was removed. May 17, another adult was taken from the cage and the remaining pupa placed in preserving fluid. These beetles proved to be specimens of Pyrochroa flabellata.

Cage No. 8.- Carabid larvae of two possible species were collected behind the plow in old timothy sod, Fayette County, Indiana, and placed in the cage April 7. (A single specimen of each species preserved in alchohol). April 12, removed one dead specimen. April 23, upon careful examination of the earth in the cage, no specimens were seen, but there were indications of their having burrowed into the sides and bottom of the cage. Upon inverting the cage, three specimens were seen to have burrowed until they reached the glass bottom and there to have made a sort of cell each. May 1, two of the larvae were seen to have pupated into white pupae with a row of long setas on the dorsum of each abdominal segment except the last. The glass bottom of the cage was removed and these pupae with their larval skins taken from the cells as well as the remaining larva. The exuviae were preserved in alchohol. The remaining larva and the pupae were again placed in the loose earth of the cage again the glass having been stuck on again with shellac. May 17, the larva and both pupae had died.

Bottle No. 1. One large carabid larva taken behind plow about one and one-half miles north of Urbana in corn stubble late in April. The larva was dark brown above, head and prothorax nearly black, prothorax with lighted band at cephalic

margin. Anal cerci not as long as the eigth abdominal segment, converging posterially until they almost meet, curving very slightly downward, apparently unsegmented. Legs with stiff spines. Anal projection as long as the ninth abdominal segment minus cerci. Small oval, brownish area on each abdominal pleurum (1-8) with another minute, oblong, dark area dorsad of the caudal end of the above mentioned dark area. Legs reddish-brown. Sterna pale yellowish. Abdominal spiracles circular. Prothoracic spiracle oblong, its axis parallel to the intersegmental conjunctivae.

Time has been taken to briefly describe this form because it was the sole specimen of its kind in the writer's collection.

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Meracantha contracta, Beauv.

1896 Wickham, H. F. Description of the larvae of some Heteromerous and Rhyncophorous beetles.
Journal N. Y. Ent. Sec., Sept., 1896, pp. 119-121, 2 Figs. (poor)

Eleodes

1912 Hyslop, J. A. The False Wireworms of the Pacific Northwest.
Bull. No. 95, Part 5, U. S. Dept. Agr. Div. Ent.

Plate 1, Figs. 4-11, Ludius.

Fig. 4, entire larva, dorsal aspect.

Fig. 5, entire larva, ventral aspect.

Fig. 6, dorsal aspect of head.

Fig. 7, ventral aspect of head.

Fig. 8, lateral aspect of right metathoracic leg.

Fig. 9, lateral aspect of fourth abdominal segment.

Fig. 10, spiracle of first abdominal segment.

Fig. 11, outline of lateral aspect of head.

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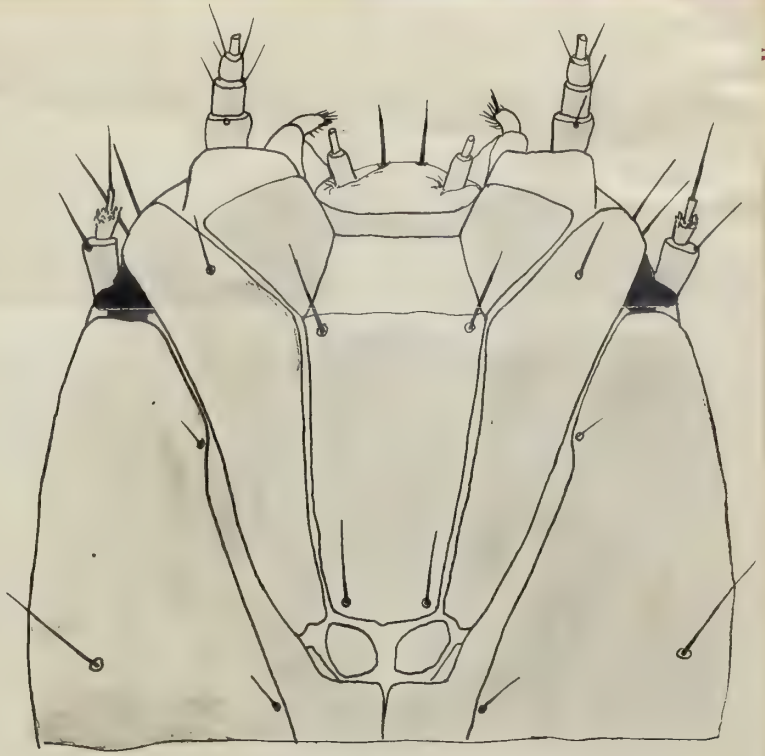

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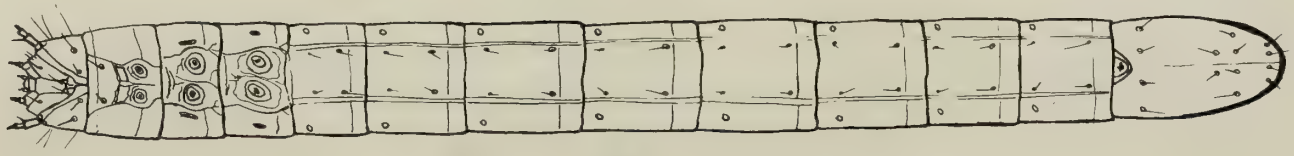

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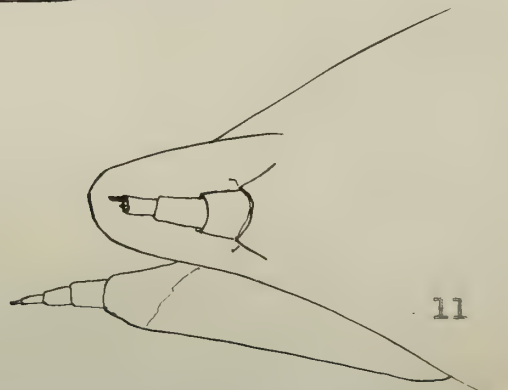

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PLATE I

Plate II, Fig. 12-27, Melanotus.

Species 1, Figs. 12-19.

Fig. 12, dorsal aspect of last abdominal segment.

Fig. 13, ventral aspect of last abdominal segment.

Fig. 14, lateral aspect of last abdominal segment.

Fig. 15, lateral aspect of fourth abdominal segment.

Fig. 16, striated muscular impressions of mesothorax and metathorax.

Fig. 17, dorsal aspect of head.

Fig. 18, ventral aspect of head.

Fig. 19, spiracles of mesothorax and abdomen.

Species 3, Figs. 20-21.

Fig. 20, dorsal aspect of last segment.

Fig. 21, ventral aspect of last segment.

Species 4, Figs. 22-27.

Fig. 22, dorsal aspect of last segment.

Fig. 23, lateral aspect of fourth abdominal segment.

Fig. 24, antenna.

Fig. 25, dorsal aspect of last segment.

Fig. 26, ventral aspect of last segment.

Fig. 27, lateral aspect of last segment.

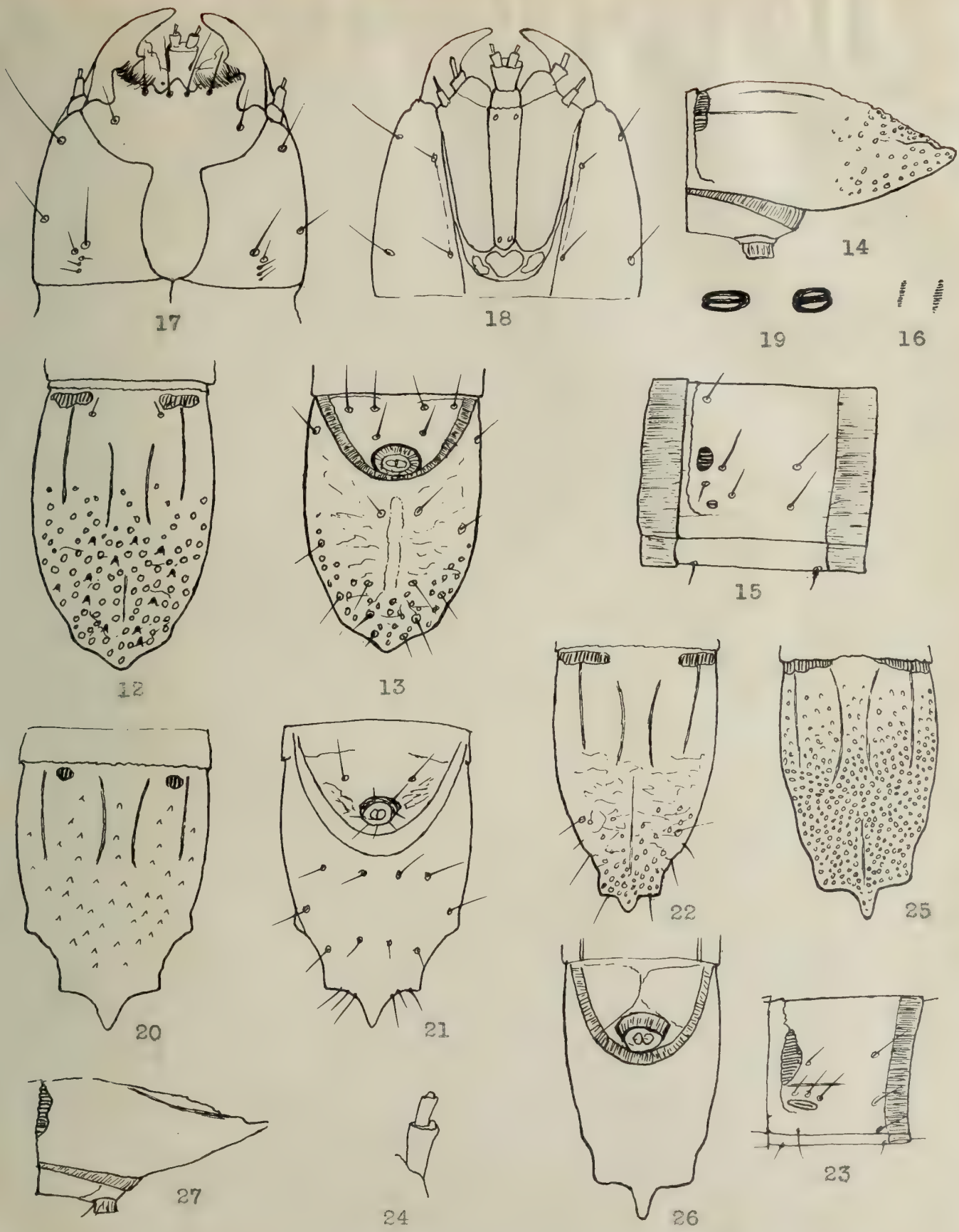


PLATE II

Plate III. Figs. 28-36 and 48-52.

Melanotus, species 5, Fig. 28.

Fig. 28, dorsal aspect of last segment.

Melanotus, species 6, Fig. 29 and 30.

Fig. 29, dorsal aspect of last segment.

Fig. 30, outline of last segment showing variations in contour.

Melanotus, species 7, Figs. 31-32.

Fig. 31, dorsal aspect of last segment.

Fig. 32, lateral aspect of last segment.

Melanotus, species 9, Figs. 33-36.

Fig. 33, dorsal aspect of last segment.

Fig. 34, ventral aspect of last segment.

Fig. 35, lateral aspect of last segment.

Fig. 36, lateral aspect of fourth abdominal segment.

Athous, Figs. 48-49.

Fig. 48, dorsal aspect of last segment.

Fig. 49, lateral aspect of last segment.

Campylus, Figs. 50-52.

Fig. 50, dorsal aspect of last segment.

Fig. 51, lateral aspect of last segment.

Fig. 52, dorsal aspect of last segment showing variations.

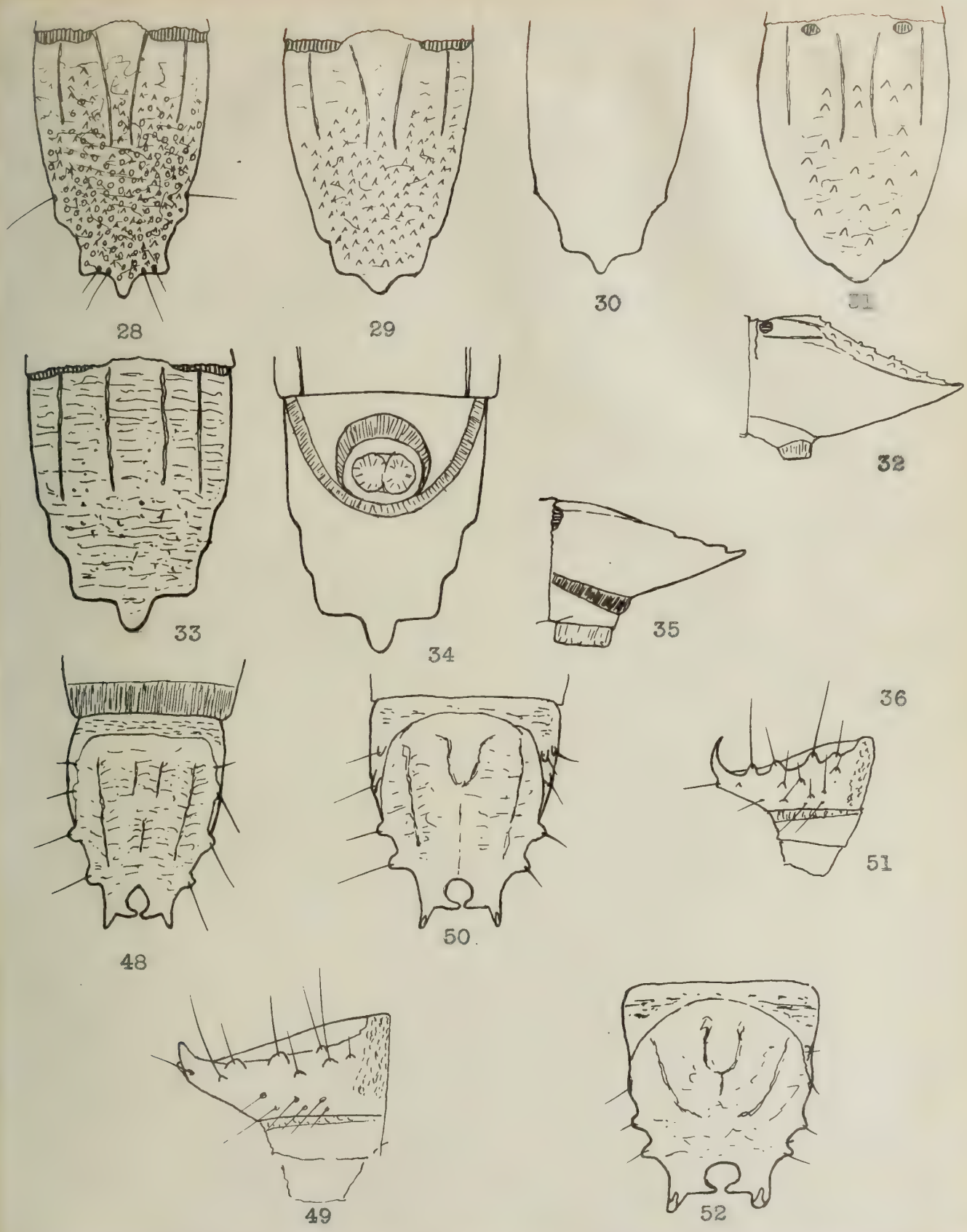


PLATE III

Plate IV. Elater, Figs. 37-47.

Species 1, Figs. 37-40.

Fig. 37, dorsal aspect of last segment.

Fig. 38, ventral aspect of last segment.

Fig. 39, lateral aspect of fourth abdominal segment.

Fig. 40, epistoma.

Species 2, Figs. 41-42.

Fig. 41, dorsal aspect of last segment.

Fig. 42, lateral aspect of fourth abdominal segment.

Species 3, Figs. 43-45.

Fig. 43, dorsal aspect of last segment.

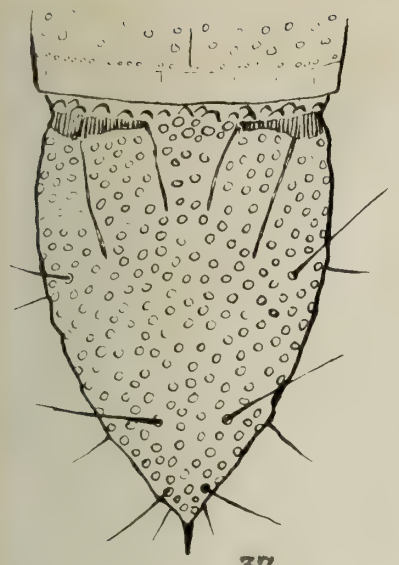
Fig. 44, lateral aspect of fourth abdominal segment.

Fig. 45, epistoma.

Species 4, Figs. 46-47.

Fig. 46, dorsal aspect of last abdominal segment.

Fig. 47, lateral aspect of fourth abdominal segment.



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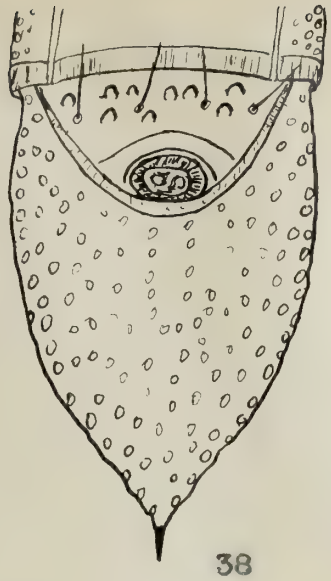

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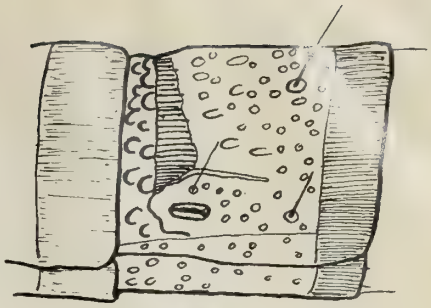

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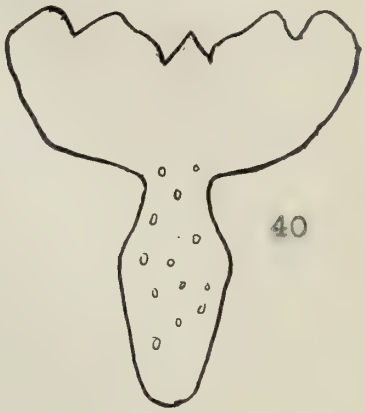

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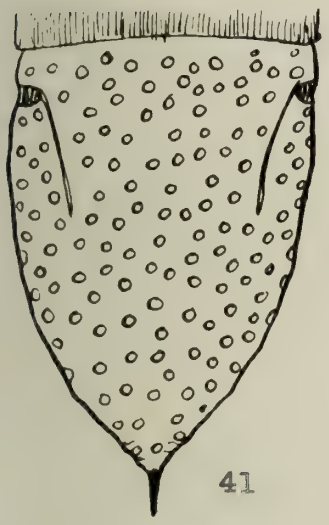

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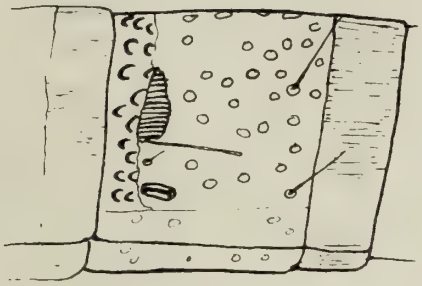

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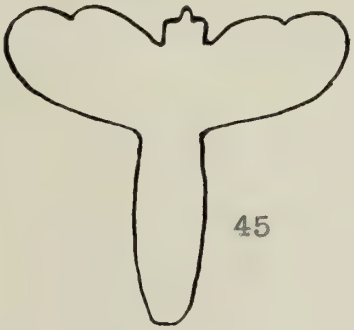

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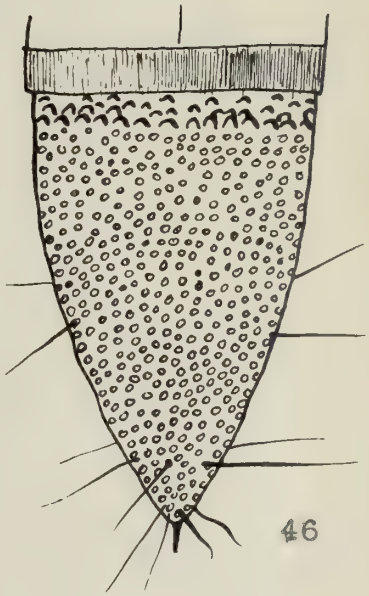

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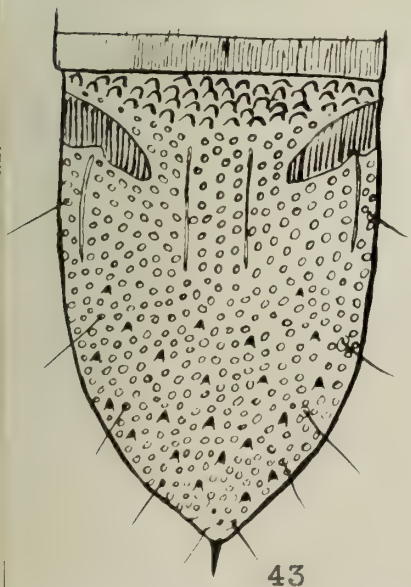

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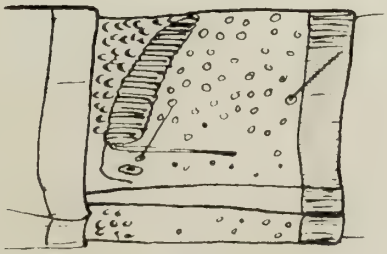

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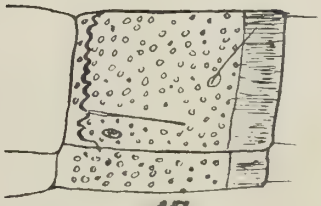

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PLATE IV

Plate V. Figs. 53-62.

Athous, Figs. 53-56.

Fig. 53, dorsal aspect of last segment.

Fig. 54, ventral aspect of last segment.

Fig. 55, dorsal aspect of fourth abdominal segment.

Fig. 56, epistoma.

Limonius, Fig. 57.

Fig. 57, dorsal aspect of last segment.

Drasterius elegans, Fig. 58.

Fig. 58, dorsal aspect of last segment. (After Forbes)

Asaphes decoloratus, Fig. 59.

Fig. 59, dorsal aspect of last segment. (After Forbes)

Agriotes mancus, Fig. 60.

Fig. 60, dorsal aspect of last segment. (After Slingerland)

Cardioporous, Fig. 61.

Fig. 61, dorsal aspect of last segment. (After Schiodte)

Cryptohypnus confusus, Fig. 62.

Fig. 62, dorsal aspect of last segment. (After Slingerland)

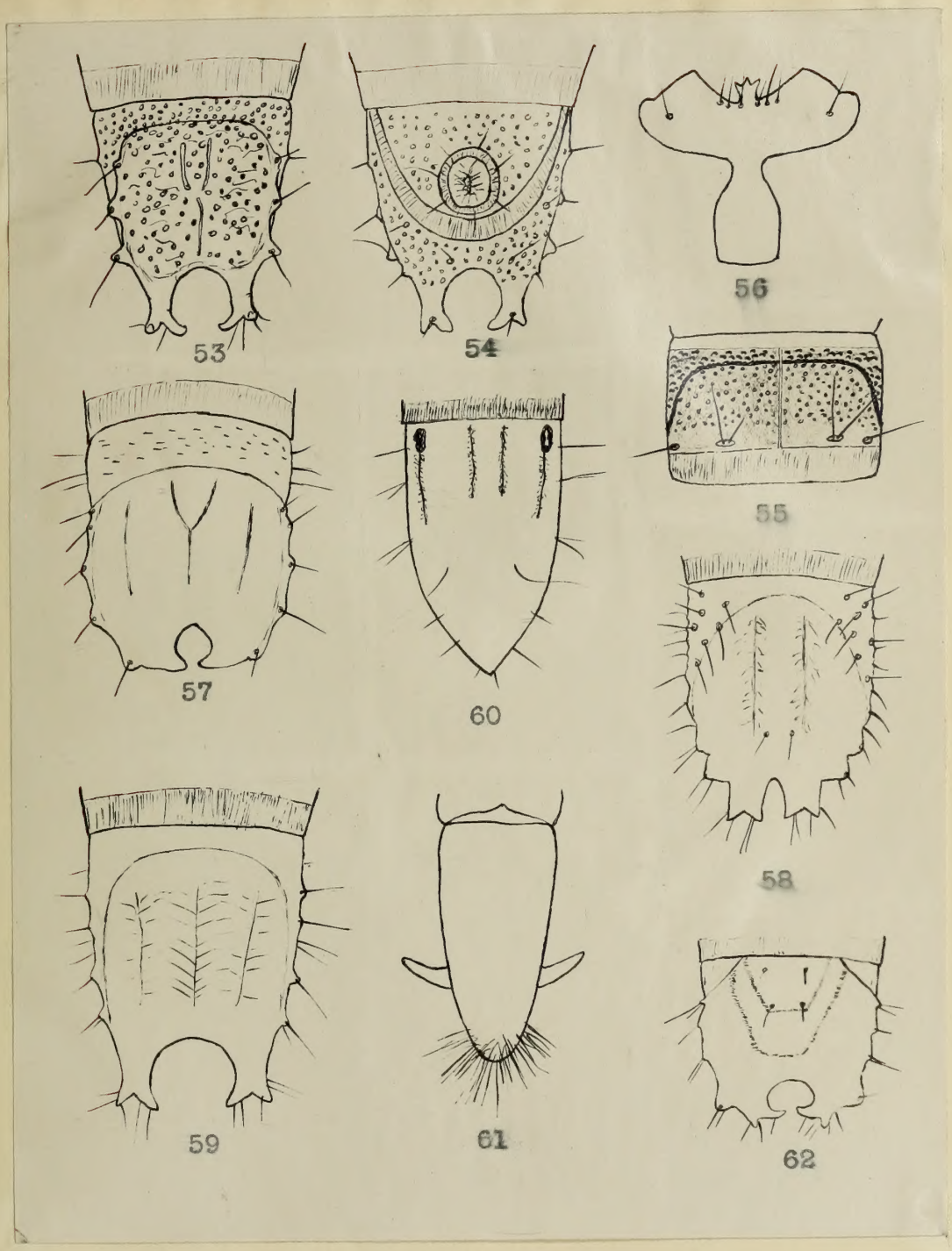

PLATE V

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